Chapter 8: System Evaluation and Conclusion

8.1 Problems Encountered and its Solutions

Many problems were encountered in the development of EWSS. Some are technical problems of hardware and software. There are also human relationship problems in implementing a project of this magnitude.

8.1.1 Username and Password for ASP.NET

One of the earliest problems encountered in developing Web Services for the .NET framework involves access privilege to access ASP.NET pages. The debugger also did not work. Compiling the application resulted in a dialog box that indicates "Unable to Start Debugging on the Web Server".

The problem was solved by changing the username to "SYSTEM" from 'machine' in the <processModel> section of the machine.config file. This file was found by just a simple file search. It is located in the WINNT\Microsoft.NET\Framework\v1.0.3705\CONFIG folder. This change makes it run as localsystem (high privilege admin) account

8.1.2 Insufficient documentation for various tools

The .NET Framework is relatively new, and although there is a vast amount of documentation, some of the documentation is incomplete. The most notable of these is the lack of documentation in the installation of technologies such as Microsoft SQL Server 2000, and even of MSDE. There is insufficient documentation on the features and usage of MSDE. They full set of functions that can be supported by MSDE have not been found.

In order to find some solutions to this problem, the Web Sites of Newsletters were consulted in addition to Microsoft's MSDN. However, the information is scarce, or is not readily available.

8.1.3 Problems in mirroring a development platform

There were many problems related to porting the development platform from home to office. Mirroring a development platform involves attempting to create the same development environment in two places, in this case because of the need to develop sequentially between home and office. Some work has been done at home. This work had to be saved and ported back to the office environment in such a way that the development work continues from where it was stopped at home. When the work was again stopped in the office, it has to be saved, and transferred back to the home. This carries on in a sequential cycle in order to speed development. Many difficulties were encountered when this process was first carried out. These problems included a thorough understanding of how SQL Server saves its database. There were also problems in understanding how Microsoft Visual Studio maintains its development environment.

8.1.4 Difficulties with the C# language

The C# language has many new features which took a lot of time to master. Some of the features involve very complex concepts that could be resolved only through reading of books or searching the Internet. There was the initial change in concept of using C# as an object-oriented language, as compared with C++ which is only partially object-oriented.

It was necessary to take more time to explore the capabilities and features of C# before the more advanced features of EWSS could be developed and implemented. One of these new concepts is learning to use the functionality provided by the .NET Framework. The other concept lies in understanding the error-handling facilities provided in C#.

There were also problems with some subtle differences between the C++-language that we were familiar with, compared with the C# language. In C#, everything had to be in a class, and all classes were derived from a single class, the `object` class.

We could not use things like global variables and macros, as was extensively used in C++. There was some initial difficulty in adjusting to the fact that, in C#, there was no fall-through in the `switch` statement.

8.1.5 Difficulties in Various components

Using the Windows Forms and their properties resulted in many difficulties. The Windows Forms editor does not give provision for aligning the objects as easily as it is done in Visual C++ 6.0. This makes the designing of the user interfaces more difficult.

8.1.6 Problems with user access rights.

Windows has some user access rights strategies, which is distinct from other components, such as the database servers. There were some difficulties in finding compatibility between these access privilege requirements.

8.1.7 Problems with Web Forms

There were problems related to the use of Web Forms. Some of these problems are related to the very nature of Web Pages, especially of state maintenance. The .NET Web Services tools assume a stateless programming model. The consequence is that each incoming request is handled independently of the previous ones. The only state maintained between requests is anything that saved or persisted in a data store.

8.2 Evaluation by End Users

EWSS has been tested and evaluated by teachers and students of CHANWA, and it has been used fully to process the examination results from Remove Form, Form One through Form Five, for the Mid-Year Examinations and Year-End Examination in 2003.

A Questionnaire was given to those users directly involved with using the system to enter the examination marks. The questionnaire was directed at just the user interface

and implementation, as they are not technically competent to comment on the architecture and design of the system. The actual questionnaire is appended in Appendix A, together with the detailed charts on each questionnaire item.

The methodology for analysis of the questionnaire involves tallying onto a Tally Form as shown in Figure 8.1. Each button increments the tally counts by one. This is a very simple user interface created specially for this questionnaire in four hours of design and implementation. Errors in tallying can be corrected in each text box. This is a specially designed program written in C# on the .NET Framework that makes tallying the questionnaire response very convenient and easy. The results were saved in a text file. The data is imported into Microsoft Excel, which resulted in Table 8.1.

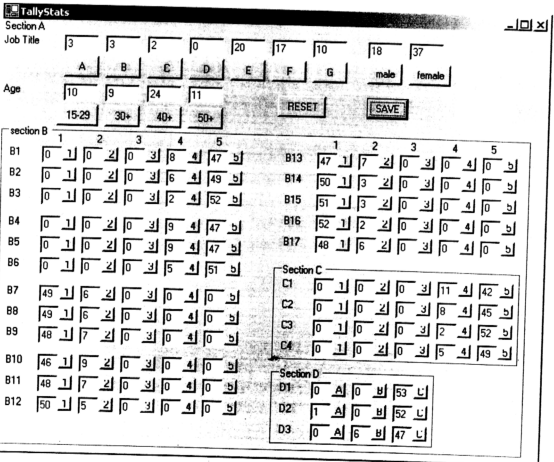


Figure 8.1 The TallyStats C# Form containing buttons that increment each questionnaire item

Table 8.1 – Results of tallying the Questionnaire responses

Questionnaire Results

Section A							
Job title	A	B	C	D	E	F	G
	3	3	2	0	20	17	10
Sex	M	F					
	18	37					
Age Group	15	30	40	50			
	10	9	24	11			
Section B							
Response	1	2	3	4	5		
Question 1	0	0	0	8	47		
2	0	0	0	6	49		
3	0	0	0	2	52		
4	0	0	0	9	47		
5	0	0	0	9	47		
6	0	0	0	5	51		
7	49	6	0	0	0		
8	49	6	0	0	0		
9	48	7	0	0	0		
10	46	9	0	0	0		
11	48	7	0	0	0		
12	50	5	0	0	0		
13	47	7	0	0	0		
14	50	3	0	0	0		
15	51	3	0	0	0		
16	52	2	0	0	0		
17	48	5	1	0	0		
Section C							
1	0	0	0	11	42		
2	0	0	0	8	45		
3	0	0	0	2	52		
4	0	0	0	5	49		

Job Title Legend

A	School Administrator
B	Department Head
C	Examinations Administrator
D	Clerical Staff
E	Subject Teacher
F	Form Teacher
G	Student

1. The manual system of entering marks is the most convenient
2. The manual system of entering marks is faster
3. We should stick to the old manual system
4. The old computerized system works fast enough
5. The old computerized system looks more familiar to the usual way of entering marks
6. The old computerized system is good enough
7. The new computerized system is more convenient to use
8. The new computerized system saves more time
9. The new computerized system is more user friendly
10. It takes a shorter period of time to enter marks in the new computerized system
11. The new computerized system is more familiar to the Web surfing applications
12. The new computerized should be implemented to replace the older system
13. The new computerized system is easier to use
14. The new computerized system is more colourful and pleasing to the eyes
15. We must use the new computerized system
16. The new computerized systems has more useful features than the old system.
17. The new system should be used in all schools

(refer to questionnaire, Appendix A)

1. Colour scheme of the various pages
2. Layout of the entry boxes
3. Look and design of buttons
4. Design of the arrangement of menu of choices of the main side box such as Enter Teacher Details, Class Info, Class-Subjects, Student Info, Enter Marks

Section D	A	B	C					Implementation (refer to questionnaire)
1	0	0	53					
2	1	0	52					
3	0	6	47					

60 questionnaires were sent out to users of the system in CHANWA, and 55 responses were received as of the date of concluding this report. The demography of the responses is shown in the Tables 8.2 to 8.4. There appear to be discrepancies in the total numbers in the tables because some chose not to reveal their gender and ages.

Table 8.2 – Job Titles

Job Title	Frequency	%
School Administrator	3	5.8%
Department Head	3	5.8%
Examinations Administrator	2	3.8%
Clerical Staff	0	0.0%
Subject Teacher	20	38.5%
Form Teacher	17	32.7%
Student	10	19.2%
Total	55	

Table 8.3 – Gender

Gender	Frequency	%
Male	18	32.7%
Female	37	67.3%
Total	55	

Table 8.4 – Age Groups of respondents

Age Group	Frequency	%
15-29	10	18.5%
30-39	9	16.7%
40-49	24	44.4%
50-59	11	20.4%
Total	54	

Table 8.5 – Summary of Section B, questions 1 – 3

Summary of responses to the manual system[1]

response	freq.	percentage
strongly agree	0	0.0
agree	0	0.0
undecided	0	0.0
disagree	16	9.8
strongly disagree	148	90.2
total	164	

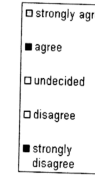
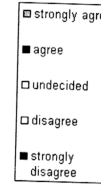


Table 8.6 Summary of Section B, questions 4-6

Summary of responses to Old DOS system[2]

response	Freq.	percentage
strongly agree	0	0.0
agree	0	0.0
undecided	0	0.0
disagree	23	13.7
strongly disagree	145	86.3
total	168	



[1] Detailed data and charts for each question are presented in Appendix A.
[2] Detailed charts for each question are presented in Appendix A

Table 8.7 Summary of Section B, questions 7-17

Summary of responses to new Web Services system[2]

response	Freq.	percentage
strongly agree	555	90.4
agree	55	8.9
undecided	4	0.7
disagree	0	0.0
strongly disagree	0	0.0
total	614	

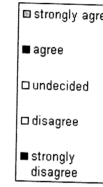


Table 8.8 Section C, User Interface Colour Scheme

Section C **User Interface**

This section deals with the design of the user interface as used in the new Web-based computerized examinations system.

Question 1 Colour scheme of the various pages

response	freq	%
1. Very bad,	0	0.0%
2. Not satisfactory	0	0.0%
3. Satisfactory	1	1.9%
4. Good	11	20.4%
5. Excellent	42	77.7%
Total	54	

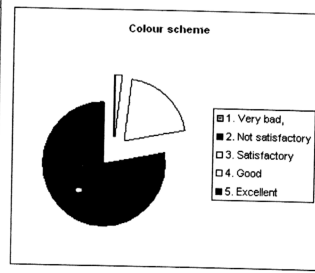


Table 8.9 Section C, User Interface Layout

Section C **User Interface**

Question 2 Layout of the entry boxes

response	freq	%
1. Very bad,	0	0.0%
2. Not satisfactory	0	0.0%
3. Satisfactory	0	0.0%
4. Good	8	15.1%
5. Excellent	45	84.9%
Total	53	

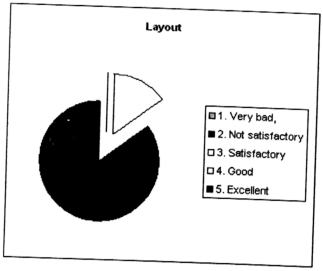


Table 8.10 Section C, User Interface Buttons

Section C **User Interface**

Question 3 Look and design of buttons

response	freq	%
1. Very bad,	0	0.0%
2. Not satisfactory	0	0.0%
3. Satisfactory	0	0.0%
4. Good	2	3.7%
5. Excellent	52	96.3%
Total	54	

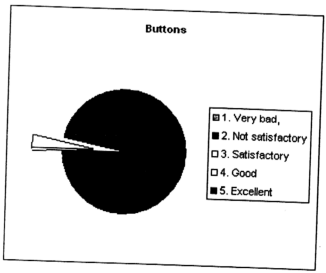


Table 8.11 Section C, User Interface Menus

Section C **User Interface**

Question 4

Design of the arrangement of menu of choices of the main side box such as
Enter Teacher Details, Class Info, Class-Subjects, Student Info, Enter Marks

response	freq	%
1. Very bad,	0	0.0%
2. Not satisfactory	0	0.0%
3. Satisfactory	0	0.0%
4. Good	5	9.3%
5. Excellent	49	90.7%
Total	54	

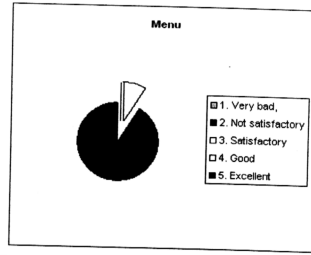


Table 8.12 Section D, Question 1

Section D **Implementation**

1 Which of the following step is the most appropriate action to be taken by the school administration concerning the new computerized system

	response	freq	%
A	Wait for more testing to be done before making a decision	0	0.0%
B	Wait until next year to implement the system	0	0.0%
C	The new system should be implemented immediately	53	100.0%
	Total	53	

Table 8.13 Section D, Question 2

Section D **Implementation**

2 What is the most important change to be made before the new system should be implemented

	response	freq	%
A	Improve the colour scheme	1	1.9%
B	The system needs a total overhaul	0	0.00%
C	No further change need to be made before implementing	52	98.1%
	Total	53	

Table 8.14 Section D, Question3

Section D **Implementation**

3 Do you need more training to use the new computerized system

	response	freq	%
A	Still cannot understand the new system	1	1.2%
B	Need more explanation of the procedures	3	3.5%
C	The system is easy enough to understand, no further training is needed	81	95.3%
	Total	85	

As can be seen from the charts above, the overall response to the system is very good. More than 90% of the respondents strongly disagree to the manual and the old DOS interface. Over 90% strongly agree to the use of the Web-based Web Services system. The surprising response is that the users as a whole preferred a better colour scheme in the written response, even though the earlier verbal response was that they liked the colour scheme. They preferred stronger colours, and a larger variety of colours in the school environment, as compared to usability studies in the corporate sector. This is attributed to the difference in preferences in people, rather than any capabilities of the system.

The other important comment from the users is the need for a more comprehensive help system. Some help tips have been added to the interface. However, a more comprehensive help system will take a much longer time to develop, and cannot be completed within the time frame of this project.

The users have also pointed out several user-interface problems which have been incorporated in the system. However, some of the suggestions touch on issues that should be handled only by the administrator. One example is the ability to delete students and teachers from the system, which is not allowed for the ordinary users.

One of the enhancements that the teachers have requested in their comments is the capability of the system to print examination result slips, instead of having to write report cards. This feature will be added as a future enhancement, which may involve some artificial intelligence capability.

The result of this user response is the total acceptance of the development of EWSS in Sekolah Menengah Jenis Kebangsaan Chan Wa, Seremban. There are several requests to develop the system further to include printing of examination slips.[3] There is also a request to extend the system to include registration of the school student particulars.[4]

At least one other school has indicated interest in purchasing EWSS to be implemented in their school. This request is being studied. There will be some changes in the requirements in order to generalize some of the features before it can be used by a variety of schools with different needs.[5]

[3] Printing examination slips require some changes in the mindset of the school administrators.
[4] Student registration is actually altogether a different system. A new system based upon Web Services could be designed for that purpose.
[5] There are several hurdles to overcome, such as licensing and software maintenance in a remote site.

8.3 Using EWSS at CHANWA

Sekolah Menengah Jenis Kebangsaan Chan Wa, Seremban (CHANWA), in Figure 8.2, is the site for testing EWSS, and the school has accepted the system to be implemented for the processing of all of the school's internal examinations results.

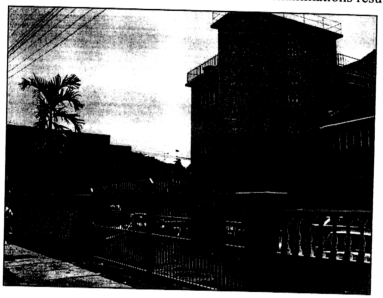


Figure 8.2 The façade of CHANWA

In the old days, before 1995, when teachers used to record and process the examinations results manually, it used to take a Form Teacher the better part of two days to complete all the calculations and filling up of a large marks sheet. If there were changes in marks for any of the students that affect the position in class, re-calculating and re-writing the marks sheet would take two hours for each change.

Such drudgery is inconceivable since CHANWA adopted the computerization of examination results. Now it takes about 20 minutes for a teacher to enter the marks of one class with the aid of students, and under one and a half seconds[6] to process each class. The overall effect is that Form Teachers are more receptive to changes in marks, whether or not it affects the position in class. Figure 8.3 shows some of the students who assisted in the data entry.

[6] Refer to Figure 7.8 for the test results

The old DOS-based computerized system took about two to three days to process a Form of eight classes. Changes to marks must be made in the same computer where the marks were entered. This was very inconvenient because, computers being shared, some other class may be using the specific computer for data entry, or for some other function, in the computer room.

Now it takes only six hours to process the whole Form, using the distributed EWSS Web Services and Web-based system. Furthermore, any changes to marks for any class can be done on any computer on the school INTRANET at any time without waiting, as long as they have the relevant access rights.

Figure 8.3 Students assisting in the data entry into EWSS

It is difficult to quantify all these performance benefits, especially in terms of satisfaction and the benefits of enabling certain services which were not possible before. However, a rough guide to its performance can be shown in Table 8.15. The performance of EWSS definitely far outweighs the manual system. The performance in terms of processing per class is faster for the DOS system, because of the overhead of Web Services. However, the overall performance improves when it comes to processing all the classes in a distributed environment using Web Services.

Table 8.15 Overall Performance of EWSS at CHANWA

Activity	Manual	DOS	EWSS	Improvement
Time to process one class	3 hours		1.4 seconds[7]	7714 times faster
		1 second	1.4 seconds	40% slower
Time to process 8 classes in one Form		3 days (18 hours)	6 hours	300% faster

Ultimately, in a school environment, the ability to process all the classes within a shorter period of time is the critical factor in the decision to adopt a system. Here, EWSS far outperforms the other systems, even giving a 300% performance benefit over the old DOS system.

8.4 System Strength

The strength of EWSS lies in the use of new technology that overcomes many of the weaknesses of the old system. It is a great improvement over previous and existing systems. The following are some of the strengths:

8.4.1 User-friendly User Interface

EWSS now uses two types of user interface. One is the Windows Forms user interface, which is more flexible. The other is the browser interface, which is familiar to every user who has been accustomed to the Internet.

The Windows Forms interface gives more flexibility and has context sensitive help. Some of the controls, especially the Datagrid is easier to program for updating of data. This interface gives better control of the system, as there are more options to choose

[7] Refer to figure 7.8 for the test results.

from. The browser interface enables a user to become familiar to the system within a short learning time.

8.4.2 Use of SQL technology

SQL is the current data manipulation language used in all modern database management systems. It is easy to use and offers some very powerful database manipulation features using a few simple lines of code. The same functionality would have taken much more lines of code, and would require much more time to program and debug.

8.4.3 More Intuitive Interface

The intuitive interface of the Windows platform is automatically a part of the program, without much effort needed to program. This contrasts greatly with the DOS interface, which is not so flexible, and difficult to design a user interface that suits most users.

8.4.4 Reliability

EWSS uses much of the latest technologies such as ADO.NET, which has improved tremendously over the earlier ADO technology. The system, especially the database manipulation routines can now rely on a proven technology that has been developed and tested by millions of users worldwide.

8.4.5 Ease of development using the newer tools

The project was developed using Visual Studio.NET. It is a tool with many features built in. As such it was possible to incorporate very useful and user-friendly features into building the system. The database manipulation, using the Server Explorer, enables a very rapid setup and modification to the database. Even stored procedures were easy to add and change.

Visual Studio.NET also has many controls available for picking from the toolbox. It was easy to control and modify the properties of these controls. This contributes to developing a more user-friendly and robust system.

8.4.6 Modular Architecture is very flexible

The modular architecture of EWSS made it very easy to add on new modules. One such add-on module was the Crystal Reports module, as described in Appendix D. The architecture allowed the addition of new modules without changing the overall architecture of the whole system.

8.4.7 Distributed system enhances overall performance

As shown Section 8.3, the distributed nature of EWSS makes it possible to alter marks on any computer in the network. This reduces waiting time, and hence improves the overall delivery time of the system.

8.5 System Constraints and Future Enhancement

8.5.1 System Constraints

The System is now being implemented on the School Intranet. As there is no internal Web Server, it is not possible for the information to be published over the Internet as a whole. However, theoretically, the same system can work over the Internet once a permanent ISP link can be established, and a Web Server configured for this purpose is set up.

There are constraints that arose from the use of the technology selected. These include limitations on Interface Design. Designing with Browser Interface involve many limitations as to the capability of some of the controls that can be chosen from the 'tool box'. There was difficulty in using the Datagrid to Update data.

8.5.2 Future Enhancements

The implementation of EWSS using Web Services opens up many new avenues for development. Since Web Services can be accessed using a wide variety of devices, students and parents could access their results from their own home computers, or even mobile devices such as hand phones, and Personal Digital Assistants (PDAs).[8] This will, of course, involve further development to design agents for downloading into mobile devices.

Apart from Examination Results, the system could be broadened to include School Activity Information, School Calendar Information, School Attendance Information, and other useful information that can be released to the public, or to restricted users governed by passwords and user access rights.

- **Performance Enhancements**

  The HTTP specification indicates that an HTTP client should not make more than two simultaneous TCP connections to any single server. ASP.NET handles incoming requests by servicing them with a pool of threads, which is called the process thread pool. Usually, when a request comes in, a thread from the pool that is idle will pop in to service the incoming request. The trouble is that the process thread pool will not create an infinite number of threads to handle a large number of requests. These factors limit the performance of Web Service requests.

One of the areas to consider when improving the performance of EWSS is the use of asynchronous Web Services. This can be programmed in the form of simulating asynchronous service calls in the asp.net pages, or programming the web services using the **PreRequestHandler** option to provide an asynchronous execution mode for making the Web service calls. Figure 8.2 below indicates the kind of performance improvements that can be expected by using asynchronous Web Services. [This chart was published in an article by Matt Powell.] There can be a performance benefit of up to eight times the number of service requests processed. More research needs to be conducted to utilize this

feature of ASP.NET pages.

8.6 Knowledge and Experience Gained

Working on this project has been a very rewarding experience. Even writing this report is a joy, even as it is wished that there were more time to write this report. Much of the knowledge gain is in the area of the use of new technology. These technologies include:

- **.NET Framework**

  Learning to use the .NET Framework is fun and enables the project to be built using a powerful platform. There were many components to this Framework, and many lessons were learned when using and applying its concepts when developing this software. This platform enables projects to be built using its capability to manage memory, that is, it is possible to develop projects using managed code. This eliminates the need to dispose of objects created, because the platform handles those almost unmanageable tasks.

  The .NET Framework has provided a platform to develop distributed applications. It provides full support for using web standards such as eXtensible Markup Language (XML) and Simple Object Access Protocol (SOAP) in a seemless manner.

  The idea that this Framework can be distributed freely makes it possible to develop projects to run on the Framework, without the user having to install the full-fledged Visual-Studio.NET, which is rather costly.

[8] This increases the cost of development as there are so many varieties of devices to test.

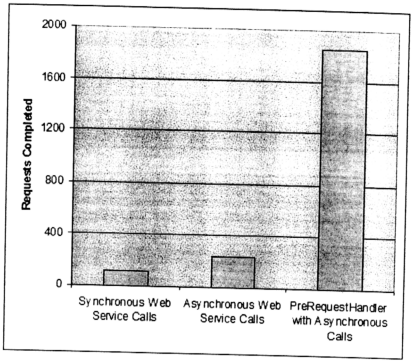


Figure 8.2 Web Service Requests completed in 60 seconds with 100 simultaneous clients

- **Visual Studio.NET**

This is a fantastic development tool that offers a means to program in three major languages that is C #, Visual Basic.NET and C++. The help system that is included in its interface is easy to use and contains many articles and tutorials that are very informative. There is so much to read that there is not enough time to read them all!

The debugging facility is excellent, and it was possible to find out problems with running the program through its help system. It was through this guided help system that many problems were solved.

- **C# Language**

C# is an exciting new language to learn and use. It is not very difficult as we have experience in the C++ language. The language is very similar to C++. In fact,

learning the C# language makes it possible to build Java components in the future, as there are many similarities with the Java language.

- **ASP.NET**

  ASP.NET offers many new opportunities to learn about programming Web pages that are interactive and dynamic. Web pages are no longer static, as they can vary according to changes in the database that they are linked to.

- **ADO.NET**

  ADO.NET is a new database access technology that has improved very much over the older ADO technology. The use of the Dataset has been very exciting, as they allow easy retrieval of data into a DataGrid control. Updating data using this control has been easy to program, although there were some new concepts to learn, such as the DataReader and the DataAdapter.

- **Using MSDE and Microsoft SQL Server**

  MSDE allows a program to use SQL to access databases that scale up to Microsoft SQL Server 2000. It offers a lightweight and inexpensive alternative to SQL Server in the learning environment. Learning this database server has enabled a speedier implementation of EWSS.

- **Windows Security Features**

  There are many aspects of Windows security that has been a mystery before. Now we know and understand some of the features and the functions provided by these Windows Security features. A more complete understanding of the Windows security features will be needed to make full use of its facilities.

- **Crystal Reports**

  Crystal Reports enables the addition of reports with charts. This project required some research on how to implement Crystal Reports Web Services, and how to

provide data to feed the Crystal Report form. The project also demonstrated how to use this Crystal Reports Web Service. The details are discussed in Appendix D.

- **Web Services**

  Last but most important, this project provided means to learn about Web Services and all the technology associated with this type of projects. We finally understood what Web Services are and how to use these ideas to solve real-life problems. There was much excitement in learning the development of service-provider functionality and how to consume these services.

8.7 A Comment on Web Services as used in EWSS

This dissertation has started as a research project with the aim of using Web Services for processing of school examinations results. One of the original stated aims was to learn about Web Services. In the course of the research, the literature presented Web Services as a means of interoperating among diverse computing platforms, especially of its ability to traverse firewalls using its text-oriented protocols, specifically the SOAP specification. The question to be asked at this point of the research is this: what advantages (or disadvantages) does the Web Services model have over other computing models in the implementation of Examinations Processing Systems?

There are some advantages in the Web Services Model as implemented in EWSS. With all the database logic implemented on the Web Server, and the use of ASP.NET, it was possible to build an online system for the entry and retrieval of results. It makes it possible to use different mix of hardware that is available in an old school computer laboratory. The performance tests indicate that the performance of the system does not depend on the platform used on the workstations, or even of the speed of the processor; it depends largely on the speed of the Web Service Server machine.

The other question that arises is this: how will this Web Services Model scale to having its Web Services functionality be available on the Internet? Who will the consumers be?

EWSS need some important design changes to make some of its Web Services be available over the Internet for external consumers. At the very least, there is the question of how to charge consumers for use of its services? As an educational function, the concept of charging consumers may not be relevant, as schools may not be willing to pay. Apart from this, EWSS is actually very tied to its database. The database model needs to be expanded to be able to accommodate separate databases for each school. Perhaps, schools could subscribe to this service, whether chargeable or not, and databases be set up for each subscribing school. They will all reuse the same Web Services.

8.8 Conclusion

This project is a real implementation in a real school environment involving over 2500 students and 100 teachers, besides the administrators. The project has lightened the load of all form teachers from Remove Form through Form Five. There is a 300% improvement in overall performance. It has provided excellent, timely and useful reports for its school administrators. EWSS has been fully accepted for implementation in Sekolah Menengah Chan Wa, and is primed for further development in that school. There have been requests for its implementation in other schools.

The project has benefited from the vast experience gained in writing software to handle these functionalities to solve one major administrative task in the school, that is, the processing of examination results. Developing this system has increased our knowledge of Web Services and many aspects of programming in C# and the .NET Framework.

Many teachers and students in the past have demanded a change in the old system, which was DOS-based. At last they have a Windows based system that is familiar and efficient. The system will benefit from many of the new technologies used in the development of the system.

Appendices

A. Questionnaire

B. Using Windows XP Home to run Web Services

C. User Manual

D. Crystal Reports

E. Sample Reports

F. References

G. Sample Reports